



U.S. Department of Energy
Energy Efficiency and Renewable Energy

DATA CENTER ENERGY EFFICIENCY TRAINING

Environmental Requirements

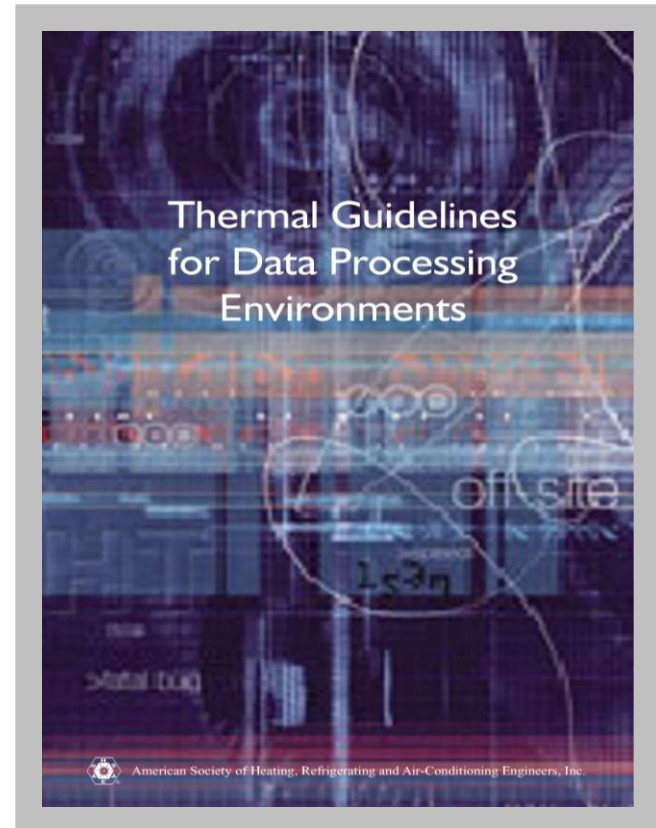


<Presenter>



Environmental conditions

- ASHRAE - consensus (2004) from major IT manufacturers on temperature and humidity conditions (no Standard)
- Recommended and Allowable ranges of temp and humidity
- Air flow required



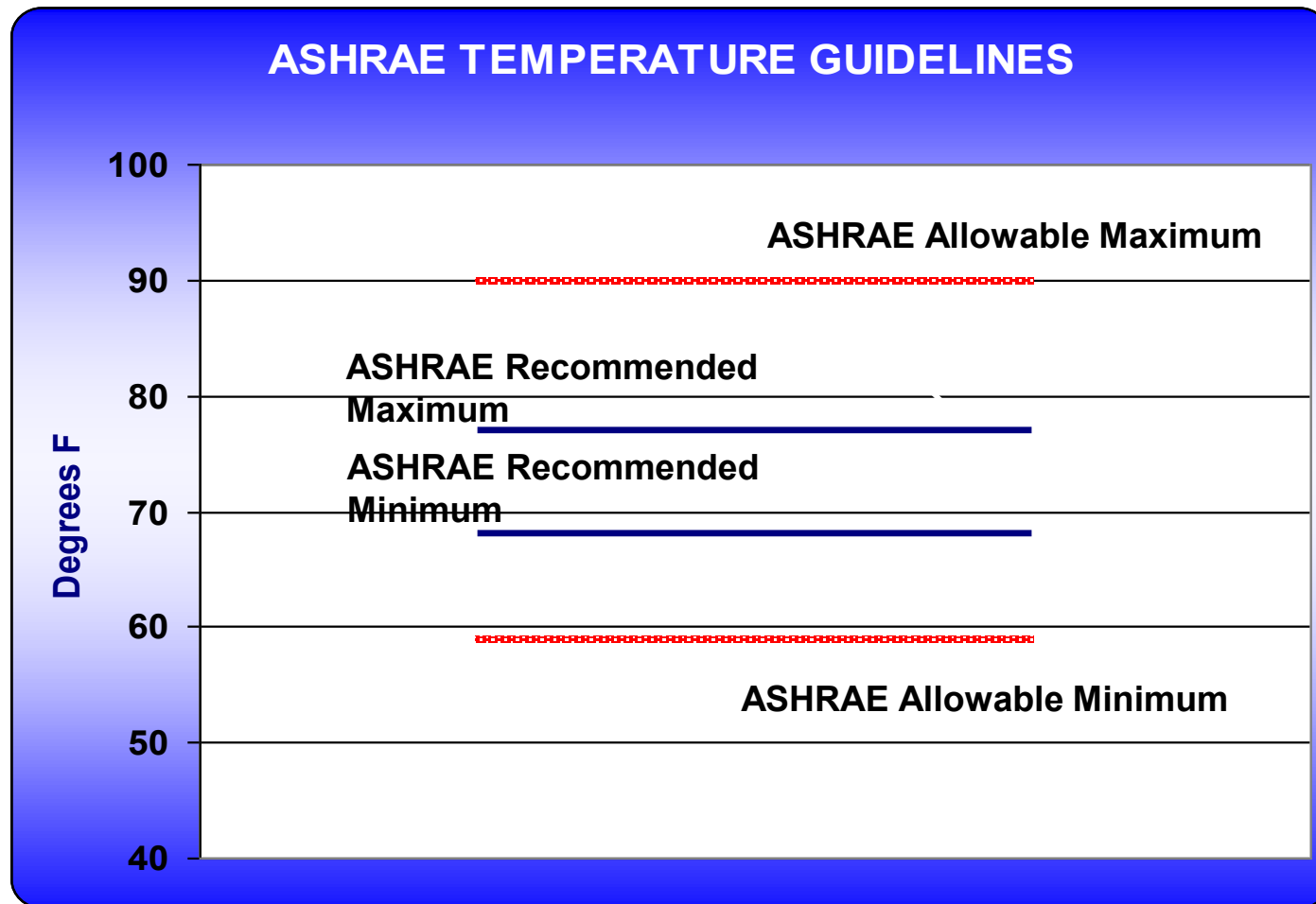


Design conditions at inlet to IT equipment

Table 2.1 Class 1, Class 2 and NEBS Design Conditions				
Condition	Class 1 / Class 2		NEBS	
	Allowable Level	Recommended Level	Allowable Level	Recommended Level
Temperature control range	59°F – 90°F ^{a,f} (Class 1) 50°F – 95°F ^{a,f} (Class 2)	68°F – 77°F ^a	41°F – 104°F ^{c,f}	65°F – 80°F ^d
Maximum temperature rate of change	9°F. per hour ^a		2.9°F/min. ^d	
Relative humidity control range	20% - 80% 63°F. Max Dewpoint ^a (Class 1) 70°F. Max Dewpoint ^a (Class 2)	40% - 55% ^a	5% to 85% 82°F Max Dewpoint ^c	Max 55% ^e
Filtration quality	65%, min. 30% ^b (MERV 11, min. MERV 8) ^b			
^a These conditions are inlet conditions recommended in the ASHRAE Publication <i>Thermal Guidelines for Data Processing Environments</i> (ASHRAE, 2004). ^b Percentage values per ASHRAE <i>Standard</i> 52.1 dust-spot efficiency test. MERV values per ASHRAE Standard 52.2. Refer to Table 8.4 of this publication for the correspondence between MERV, ASHRAE 52.1 & ASHRAE 52.2 Filtration Standards. ^c Telecordia 2002 GR-63-CORE ^d Telecordia 2001 GR-3028-CORE ^e Generally accepted telecom practice. Telecom central offices are not generally humidified, but grounding of personnel is common practice to reduce ESD. ^f Refer to Figure 2.2 for temperature derating with altitude				

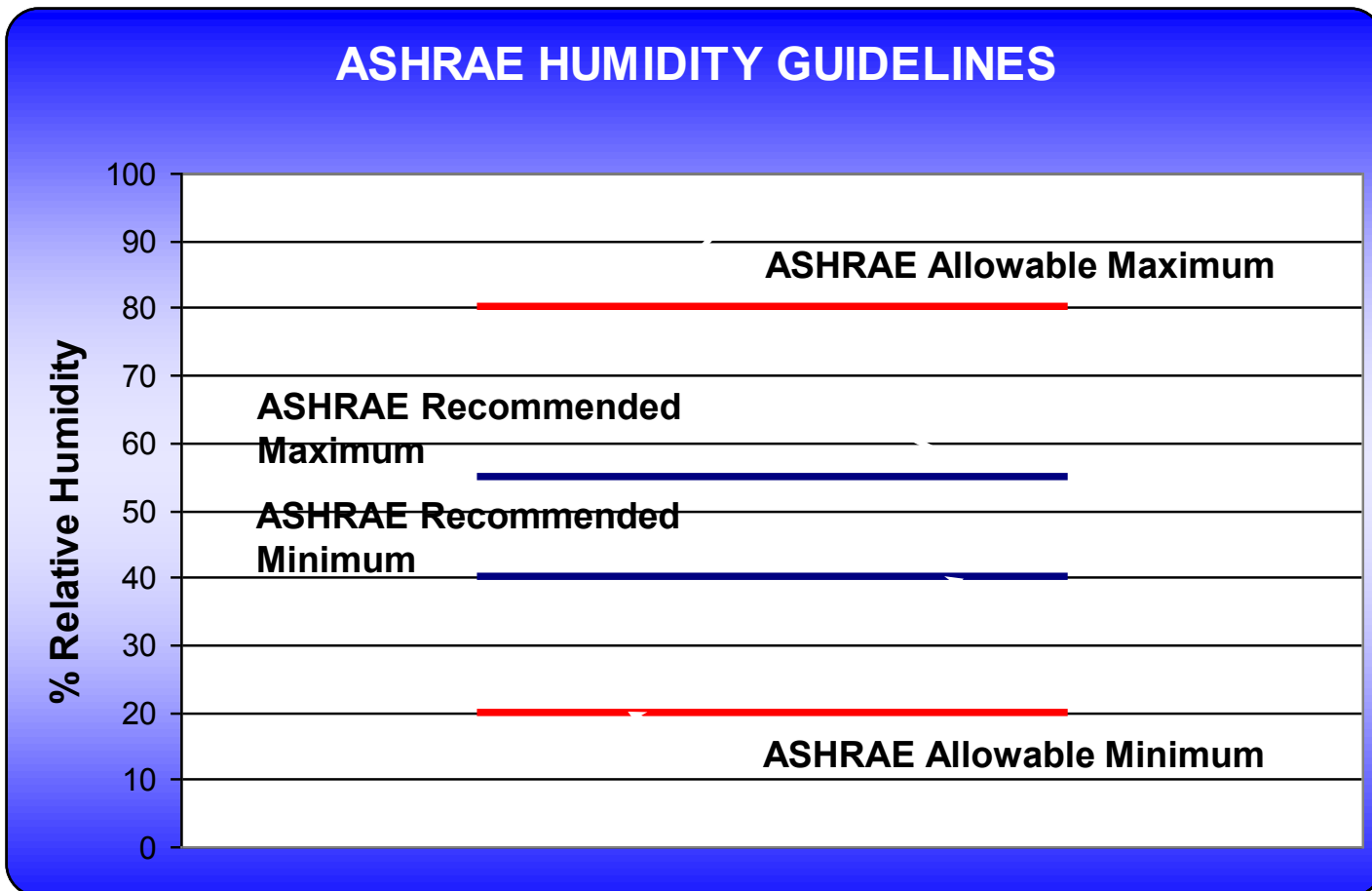


Temp Guidelines – at Inlet to IT Equipment





Humidity Guidelines—at Inlet to IT Equipment



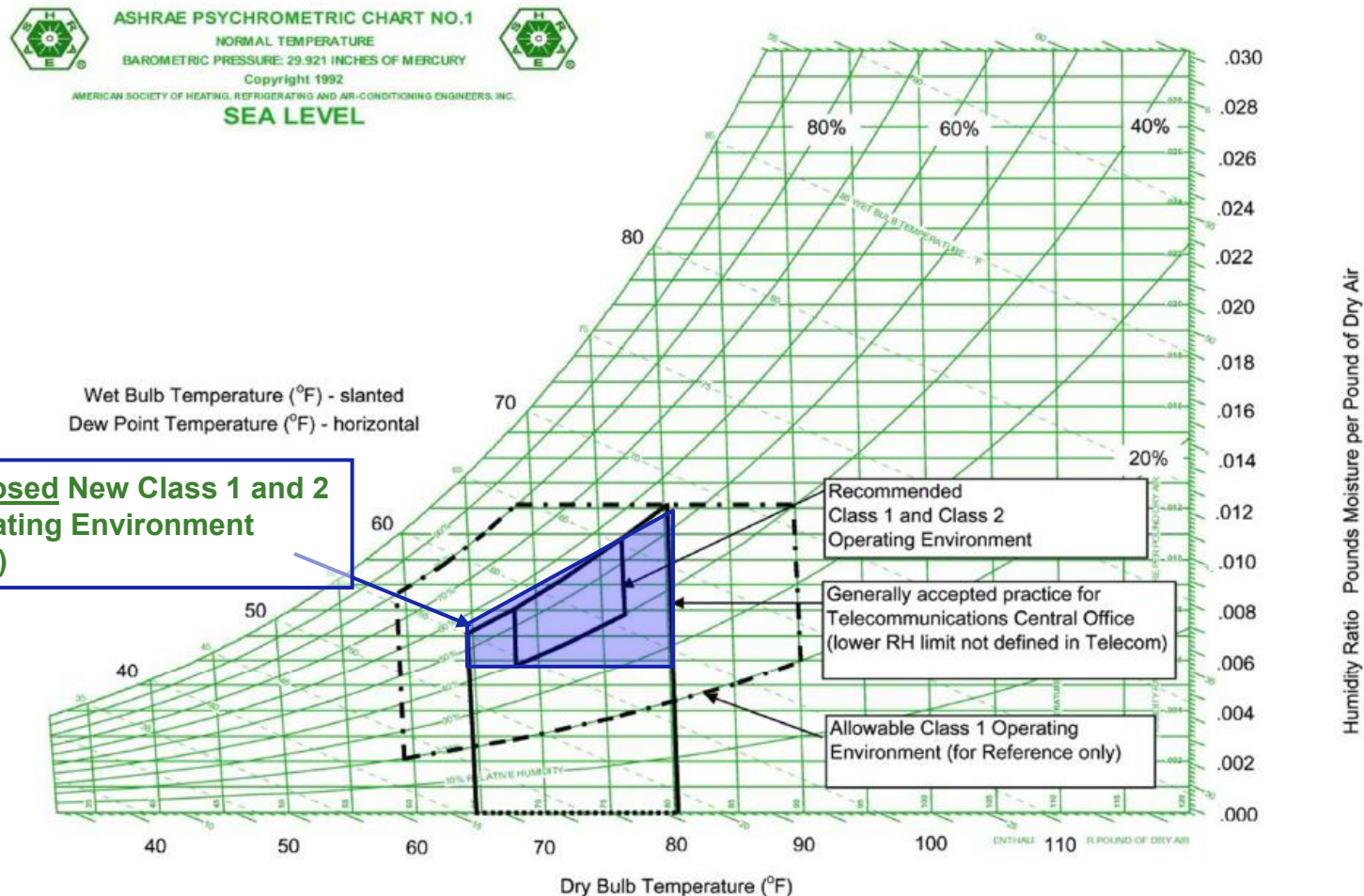


Lower humidity limit

- Mitigate electrostatic discharge (ESD)
 - Recommended procedures
 - Personnel grounding
 - Cable grounding
 - Recommended equipment
 - Grounding wrist straps on racks
 - Grounded plate for cables
 - Grounded flooring
 - Servers rated for ESD resistance
 - Industry practices
 - Telecom industry has no lower limit
 - The Electrostatic Discharge Association has removed humidity control as a primary ESD control measure in their ESD/ANSI S20.20 standard
 - Humidity controls are a point of failure and are hard to maintain
 - Many data centers operate without humidification
 - This needs more research
- And for some physical media (tape storage, printing and bursting)
 - Old technology not found in most data centers
 - It is best to segregate these items rather than humidify the entire data center



Design conditions at inlet to IT equipment



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ESD control: floor grounding

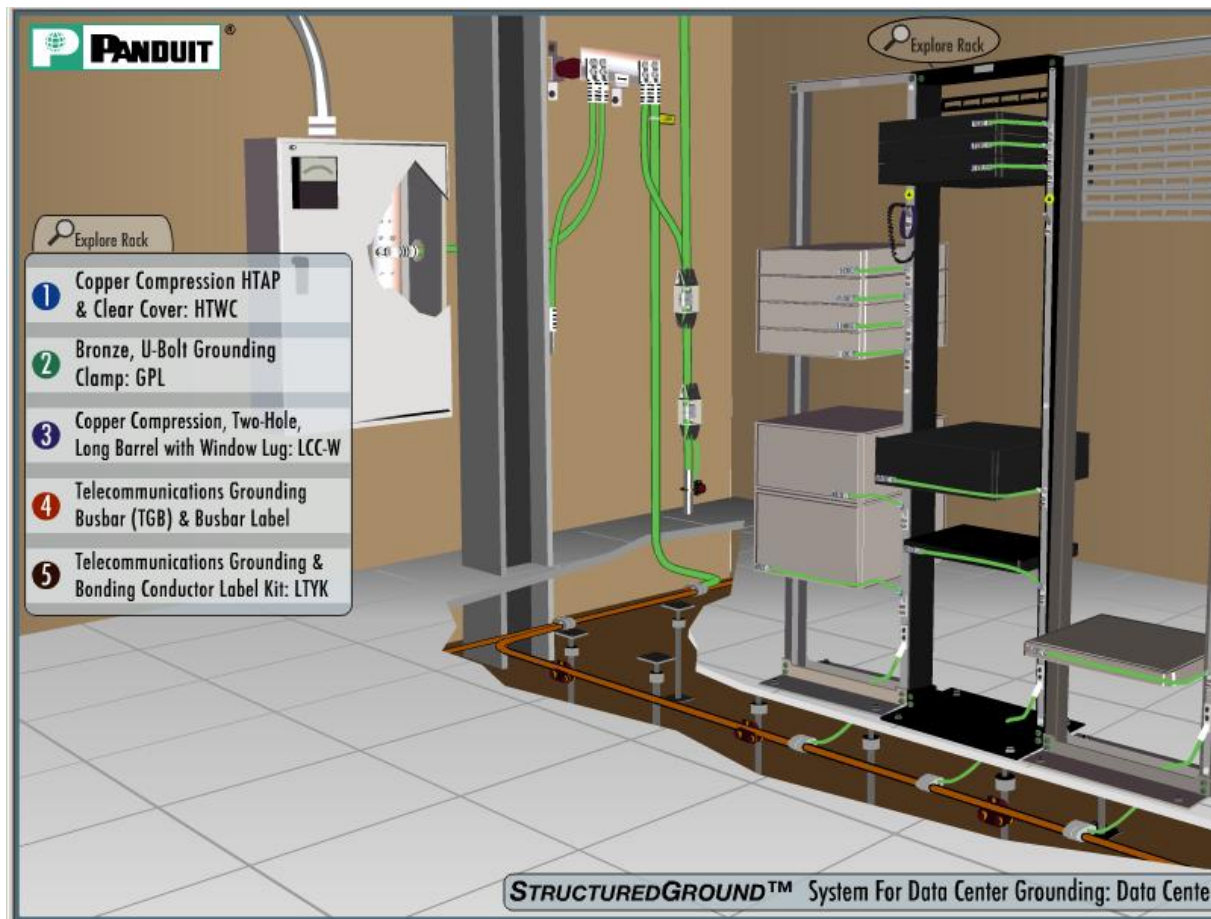


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What's the IT equipment airflow?

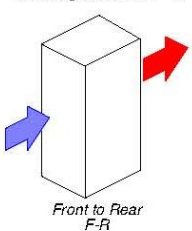
	SUN	SUN	DELL	DELL
	V490	V240	2850	6850
num fans	9	3	n/a	n/a
total CFM (max)	150	55.65	42	185
total CFM (min)			27	126
fan speed	single speed	variable	2 speed	2 speed
fan control	n/a	inlet temp.	77F inlet	77F inlet
Form Factor (in U's)	5	2	2	4
heat min config (btuh)		798		454
heat max config (btuh)	5,459	1,639	2,222	4,236
heat max (watts)	1,599	480	651	1,241
dT min config	-	13	-	3
dT max config	33	27	48	21
servers per rack	8	21	21	10
CFM/rack (hi inlet temp)	1,200	1,169	882	1,850
CFM/rack (low inlet temp)	1,200		567	1,260
max load / rack (kW)	13	10	14	12



Thermal report

XYZ Co. Model abc Server: Representative Configurations

Description	Condition							
	Voltage 110 Volts			Airflow, Maximum at 35°C		Weight		Overall System Dimensions ^b (W × D × H)
	Typical Heat Release	Airflow ^a , Nominal						
	watts	cfm	(m ³ /h)	cfm	(m ³ /h)	lbs	kg	in. mm
Minimum Configuration	1765	400	680	600	1020	896	406	30 × 40 × 72 762 × 1016 × 1828
Full Configuration	10740	750	1275	1125	1913	1528	693	61 × 40 × 72 1549 × 1016 × 1828
Typical Configuration	5040	555	943	833	1415	1040	472	30 × 40 × 72 762 × 1016 × 1828

ASHRAE Class 1, 2, 3	<p>Airflow Diagram Cooling scheme F-R</p> 	Minimum Configuration	1 CPU-A, 1 GB, 2 I/O
		Full Configuration	8 CPU-B, 16 GB, 64 I/O (2 GB cards, 2 frames)
		Typical Configuration	4 CPU-A, 8 GB, 32 I/O (2 GB cards, 1 frame)

a. The airflow values are for an air density of 1.2 kg/m³ (0.075 lb/ft³). This corresponds to air at 20°C (68°F), 101.3 kPa (14.7 psia), and 50% relative humidity.

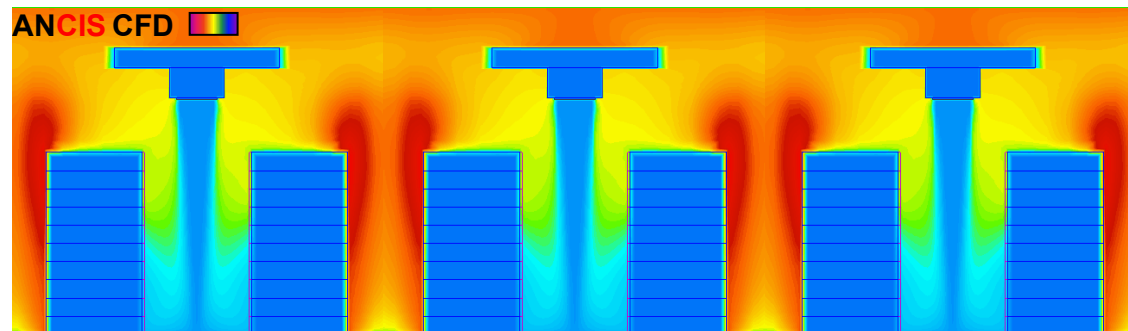
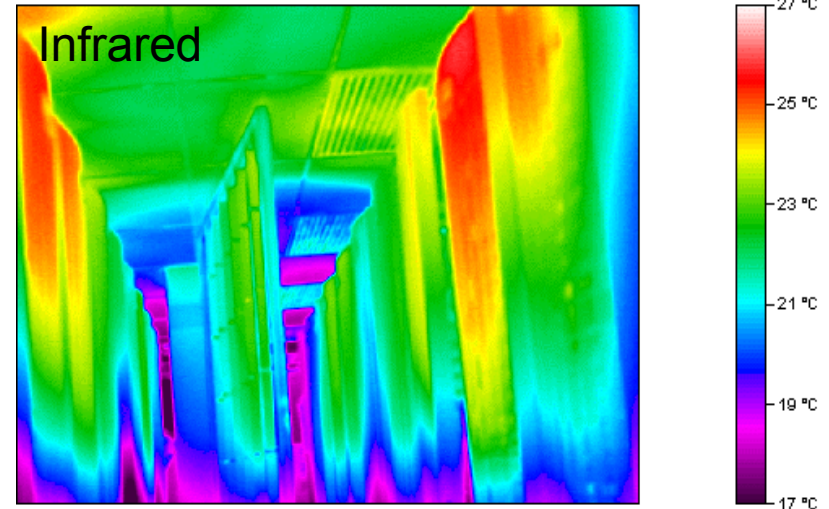
b. Footprint does not include service clearance or cable management, which is zero on the sides, 46 in. (1168 mm) in the front, and 40 in. (1016 mm) in the rear.

From ASHRAE's Thermal Guidelines for Data Processing Environments



Visualizing Temperature and Airflow

- Computational Fluid Dynamics (CFD) modeling
- Temperature sensor networks
- Infrared thermography





Zoning

- Some IT equipment (e.g. storage) requires tighter control
- Don't penalize the whole center for a few pieces of equipment
- Different zones should be provided